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SEWAGE FARMING:

I.

The Duty of a Locality to utilise the Nitrogenous Matter in its Sewage for the benefit of the Nation.

II.

The Power of Soil and Vegetation combined to destroy Disease Germs, and so prevent the possibility of the spread of Enthetic Disease in consequence of Sewage Farming.

Papers read at the International Congress of Hygiene and Demography, 1891, *in the Chemical Section.*

President:—SIR HENRY ROSCOE, M.P., F.R.S., &c.

BY

ALFRED CARPENTER, M.D.

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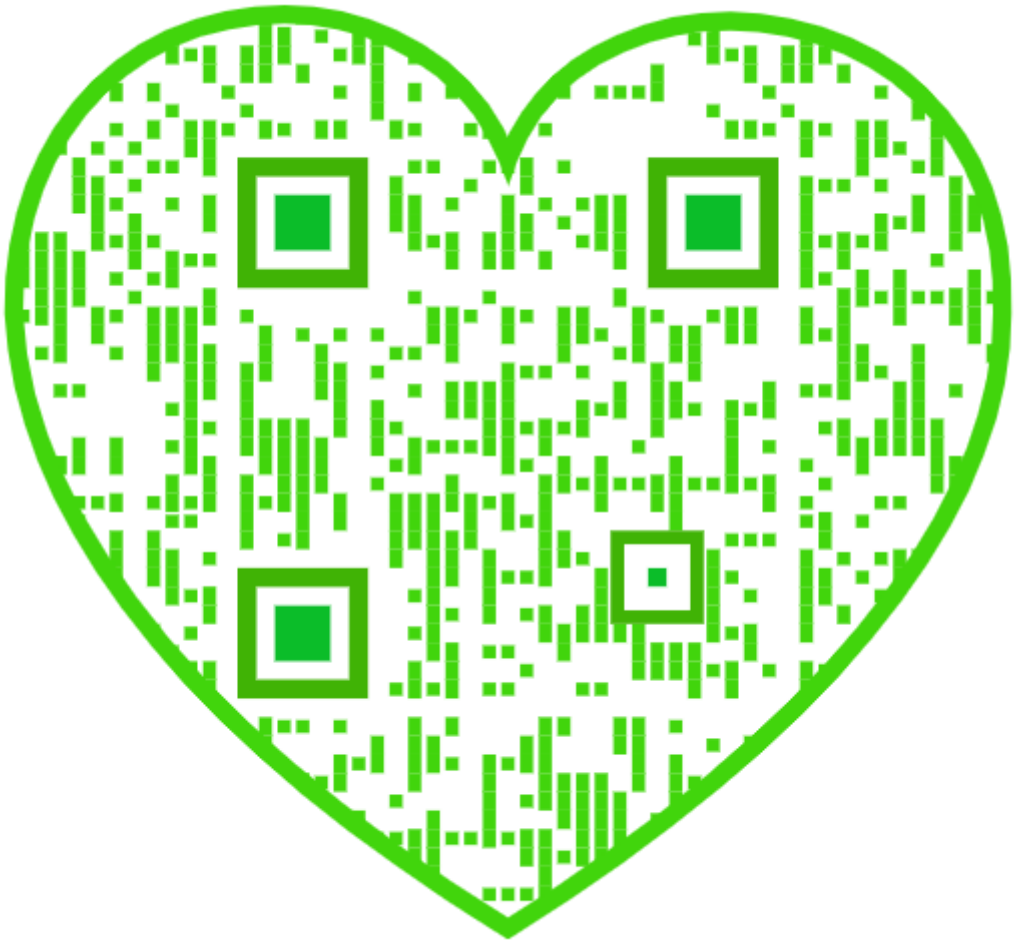

The Duty of a Locality to Utilise the Nitrogenous Matter in its Sewage for the Benefit of the Nation.

By ALFRED CARPENTER, M.D.

THE object of this paper is to show that localities have duties to the nation to which they belong. It is not a sound argument to assert that the performance of these duties may have an apparently adverse result for the time being, by causing considerable expense. Some other course may possibly save the local authority an immediate capital expenditure, but if that course be persevered in, it may lead to much loss and mischief to the nation. The transportation of felons (the refuse of society) to the other side of the world, appeared for the time to save this country much trouble, but perseverance in that course would have involved disastrous results. In the case of sewage refuse, when the land is deprived of its natural requirement agricultural exhaustion ensues. It is one of the laws of nature that plant life is required for the support of animal existence, and the converse is also true, that growth of animal matter is necessary for the continued development of vegetable produce. The fruits of the earth, which are especially wanted for human subsistence, require for their rapid growth the continued or occasional application of ammonia,

and various other salts, in addition to carbonic acid. As the density of population increases, the safety of the people requires that the land should have greater and more rapid powers of reproduction, and nature has not been regardless of this postulate. It is quite possible for a thickly peopled district to provide food for all its inhabitants without importing food stuffs. France, Holland, and Belgium, and more especially China, India, and Japan, are instances in point. It is true that famines have arisen, as the result of war or of extreme meteorological conditions, but the fact remains, that excluding these influences, the land has grown, and can grow, produce sufficient to support a densely peopled district. This has been brought about by the careful application of the excreta of the people to the soil itself, and a high state of cultivation has procured large crops for the use of the inhabitants, while at the same time they have been preserved from the incidence of pestilence.

In consequence of the increase of wealth, and from other causes, such as the necessity for protection against the inroads of barbarians, or when a feudal baron had to protect himself against his next neighbour, people surrounded themselves with high walls, giving up in this country the habits of their Celtic and Saxon ancestors, who had wiser plans for the disposal of human excreta than their Norman successors. Human refuse then began to be stored in pits and cesspools, by which the subsoil in the towns and their immediate neighbourhood was polluted, and the progress of epidemics assisted whenever the meteorological conditions required for their manifestation arose.

The earliest hygienic indications which are found on record are in the Bible. Moses, the great Hebrew lawgiver, ordered that human excreta should be conveyed to the earth, without the camp, and after the settlement in the land of Canaan, without the city, and all polluted

articles, either of clothing or anything else, well washed with water. This law, established by a despotic authority, involved two points, first, the agricultural use of human excreta and its immediate conveyance to the soil; and secondly the absolute necessity of an abundant supply of water.

As cultivation of the soil was the main source of wealth to the Hebrews, they soon became wealthy, and with riches came indolence and neglect of the laws laid down by Moses. They allowed their dwellings to be polluted, and prepared the way for their own overthrow by agents styled in Holy Writ "the armies of the living God"—that is to say, the murrain among their cattle, the blasting, or blight, and mildew upon vegetation, with the palmer worm, the canker worm, and the caterpillar. These were clearly the disease germs which have only been scientifically demonstrated in recent years. It has been proved that their powers of multiplication are promoted by soil, air, and water polluted by human excrement, and when these pollutions are prohibited by authority, and their causes prevented, the locality which expends the necessary capital is ultimately repaid a thousandfold.

Coming to our own time, I venture to assert that a rate of a shilling in the pound, if judiciously dealt with, may be incurred with the certainty that its value will come back again. It is necessary that this expenditure should be general throughout the country, in order that complete results may be obtained. The law in this country has now decided that one locality shall not pollute another by casting its refuse outside its own boundary. It has come to pass that the cost of sanitary works, though great in the first application, has, in those districts where it has been judiciously applied, been productive of immense pecuniary benefit in the saving from sickness, incapacity from

depreciated mental and muscular power, and early death. But while recognising the law as to cleanliness, the country generally has not awakened to the mischiefs which result from a neglect of the other portion of the ordinance. Human excreta is not as a rule conveyed to the soil, but impediments are placed in the way of its utilisation in this manner by many landowners and local authorities, with the result that agricultural produce is correspondingly diminished, and while population is increasing, the people are rendered more and more dependent upon foreign countries for their food supplies. For more than 800 years human ordure has been mainly buried in the earth or passed away into the sea, or, worse still, into our running streams. By these means "the armies of the living God," the disease germs of modern times, have destroyed millions of people in the prime of life, and nature has been avenged for the neglect of sanitary law. Every human being discharges daily so many grains of phosphatic salts, and of material which becomes ammonia. Ammonia if not at once agriculturally utilised is reduced to its elements, carbonic acid and water, thus losing 95 per cent. of its agricultural value, while the phosphates remain locked up in the cesspit, or pollute our water supplies. Phosphates are wanted for our wheat and other crops, and should be returned to the soil in the form in which they exist in human excreta. Had this been done, as ordered by our earliest authority on hygienic law, the constant re-application of the salts would have reacted on the principle of small profits and quick returns, to the immense advantage of the people of the land.

There are several denunciations in Holy Writ, usually omitted in our public services, against those who pollute the walls of the city by micturition. No one can pass along the streets of any town or village in the kingdom, after

10 o'clock at night, and especially after the public house closing hour, without witnessing the continuance of this act in our own time. I cannot exaggerate the evil, or say too much to draw the attention of local authorities to the mischiefs which result from the continuance in our cities, towns, and villages, of this indecent habit. Its denunciation in Scripture is not, in my opinion (as generally supposed), intended to indicate a judgment upon the people at large, but for the purpose of pointing out a breach of sanitary law in which the drunkard and the profligate indulged in Israel, as much as they do in Britain to-day. By this act the passer-by soon after may inhale a material capable of providing a forcing bed for disease germs, and allowing of the production of some of those forms of influenza and other catarrhal disorders which are so puzzling to the student in the etiology of epidemic disease, and are often the basis on which is established organic disease. These offences against decency are offences against the health of the community, and are taking from the nation a power to return to agriculture that which is required for the nation's welfare, for the larger part of the agricultural value of sewage is found in the urine. The denunciation of this act in Scripture is therefore called forth by a disobedience to hygienic law.

The habit helps to spread infectious disease. It also prepares the way for famine by removing from their proper place ingredients required for the nourishment of plant life in their most available form. It is often said that it will not pay a locality to utilize its sewage in the manner which I advocate—that to spend a sovereign in a way only likely to bring back ten shillings is economically wrong. This might be so if there were no other contingencies to be considered. But let me put before you the results of sanitation in my own town. A death-rate of 26 per thousand,

and a rating equal to 6*s.* in the pound, more than 35 years ago, was followed by the capital expenditure of some £600,000 in sanitary works for a population of 36,000 persons, gradually increasing in numbers as the expenditure went on. The death-rate has averaged, for the past ten years, 14 per thousand, and the rating is at this moment 5*s.* 4*d.*, though, in addition to a high Metropolitan Police rate, a School Board, public baths, public libraries, and nine public parks for the recreation of the people have been established in the district. The expenditure on sanitary works gives a beneficial return to the locality as well as to the nation, and has added much wealth to the district in which the works have been carried out.

The people of Croydon have expended some £230,000 in the purchase of land for the purpose of sewage utilization during the past thirty years. They were prohibited by law from fouling the Wandle river, and injunctions obtained against the local authority before the year 1860 have never been dissolved, yet the effluent from the sewage farm has been discharged into the Wandle, and the authority has been unmolested by law ever since they applied the sewage to the land in the manner which is termed broad irrigation, while the cost to the ratepayers (exclusive of the purchase of the land) has never exceeded a twopenny rate. What have we had for this rate? Improved health, the employment of a large number of hands at improved agricultural wages, exceeding by five times the number formerly employed on the same land, a large increase in the amount of meat and milk at the service of the people, and, so far, the nation ensured against the chance of evil from scarcity. Surely these results are far in excess of the burden imposed. It is, in my opinion, a national mistake to allow the continuance of waste in the face of such national advantages.

Let me now turn to the condition of the Thames. It

receives the sewage of the metropolis, which is treated chemically at an immense cost to the London County Council. The Croydon local authority used a lime process when the sewage was first applied to the land, it being then supposed to be a necessity of the work. Some large sums were annually expended in this operation, and nuisance was actually produced by the sanitary authority in the places where the tanks existed. These were removed some fifteen years ago, and the sewage has ever since been discharged directly upon the land, without any other process than a rough straining through wire guards. The expense of treatment in tanks by the lime process has been saved and it has been clearly demonstrated by our experience that such treatment is entirely unnecessary. If fresh sewage is discharged immediately upon the land before putrefaction has commenced, no evil will result to the locality to which it is conveyed. If sewage is kept moving at a fairly rapid rate no opportunity for putrefactive action will be given, and the sewage may be conveyed forty or fifty miles in either closed or open courses with safety, provided that the closed mains are kept filled with moving sewage.

Let me apply the principle of this form of utilization to the sewage of London. Take the population at about 4,000,000. The average agricultural value of the refuse of each individual may be roughly estimated as equal to that of a sheep for the same purpose. This has been put at 5*s*. per head by competent authority. Assuming this to be a minimum value, the sewage of London is worth, in the abstract, a million a year, independently of the national advantages which would result from its utilization. Let us assume, for a moment, that these advantages would justify the nation in guaranteeing the interest of 3 per cent., or £20,000,000 devoted to such a purpose. If that amount were judiciously expended in promoting the Canvey Is-

land or Maplin Sands' scheme, together with the erection of pumping stations at favourable points on the present collecting sewage outfalls, with covered rising mains conveying the sewage to high lands beyond the populous districts around the metropolis, immense areas of barren, uncultivated land might be converted into farms, producing luxuriant crops, and large agricultural populations would be provided with the means of subsistence, while increased supplies of milk, meat, and vegetables would be at the command of the people, and, so far, there would be diminished scarcity of supplies in the event of complications with foreign nations. This would help to bring about the effects which are expected to result from the principle of allotments, now so strenuously urged upon Parliament by the advocates of healthy employment for the people. The estuary of the Thames would be freed from a condition which is a standing disgrace to a civilized community, and which, if persevered in for another half century, will inevitably damage the navigation of the river, and consequently the trade of the port of London. Seven or eight years ago I acted as one of a committee for the erection of a third lunatic asylum for the county of Surrey. We arranged for the utilization of the sewage of 1,200 inmates by broad irrigation. The area irrigated is absolutely within a stone's throw and in front of its principal entrance. I append a letter received from the medical superintendent as to the result. I may add that the asylum has recently passed out of the care of the Surrey magistrates into the hands of the London County Council.

London County Asylum,
Cane Hill, Purley, R.S.O.,
April 4, 1891.

DEAR DR. CARPENTER,

. . . . . .

No report on the result of our sewage utilization has been recently published. The sewage, as you are aware, is disposed of here in the

land by gravitation. The process is simple in the extreme, one man managing the whole affair.

1. The health of the population of the asylum is unaffected in any way. Not the slightest discomfort or nuisance arises from the land irrigated, and this although it immediately adjoins the Brighton Road.

2. Italian rye grass is grown in large quantity, and is consumed as summer feed by the cows and horses. The portion irrigated is cut for two years, then ploughed and cropped for the two following with roots (mangold) and oats.

3. Financially, there is considerable profit, as the stock would require a much larger area of land if fed by grazing, or else a large outlay for some substitute for the rye grass.

Amount of land irrigated, nine acres. Asylum population, 1,250. No effluent.

Believe me,
Yours very truly
JAMES MOODY.

About twenty years ago, the burgomaster of Dantzig, with a deputation from the governing body of that city, visited Croydon, and inspected our sewage farm. As a consequence of that inspection and of other information afforded to them, a sewage farm has been established at Dantzig. I now publish a letter from the manager of the farm.

Danzig Sewage Farm,
September 1, 1890.

DEAR SIR,

I have been following, with great interest, the accounts in the "Times" of the meetings of the Sanitary Congress, and I cannot help writing you to confirm, from my experience, the views which you have expressed, viz., "the establishment of a number of sewage farms would be better. It would be more desirable, instead of wasting the sewage, to distribute it over an area where it could fructify. With people so much in need of meat and milk as Londoners were, it was criminal to destroy such a valuable means of production of those commodities." I have no doubt whatever the County Council will soon find itself compelled to do something besides polluting the seaside as well as the Thames, and no better beginning could be made than by carrying out the Maplin Sands or even the Canvey Island scheme. I am confident the result would be satisfactory, and that other sites would soon be offered or found. It is to me quite incomprehensible that the Council has taken no opportunity of viewing the Berlin sewage farms, which, despite the enormous outlay, are a most complete success. If the 1,720,000 inhabitants and ratepayers are *quite* agreed as to this,

surely it is worth while looking at. Our farm here in Danzig has been visited this year by a great number of authorities from all parts of the world, exciting wonder as well as interest, for year by year the results are more satisfactory, financially as well as agriculturally. Only last week we entertained a large party of visitors from Austria, who were very much astonished to find whole plantations of Edelweiss, and to drink the capital red currant wine which is so much esteemed here, produced on the sand of the sea shore by the utilization of the Danzig sewage. Asparagus continues to be one of the best paying products, and commands a much higher price than that produced on the inland farms.

Yours respectfully and faithfully,

ALEX. AIRD.

Alf. Carpenter, Esq., M.D.,

In addition, I may add the testimony given by Dr. C. E. Saunders, Medical Superintendent of the Sussex County Lunatic Asylum. When the congress of the Sanitary Institute was sitting at Brighton last year he invited the members to view the irrigated land at Hayward's Heath. He stated that the food grown upon the farm had all been consumed directly or indirectly, within the asylum, and he pointed to the comparatively low death-rate at the asylum, and the absence of all zymotic maladies, as a clear proof that the food used was free from all disadvantages.

I propose to deal with the objections that have been made on sanitary grounds to sewage farming in a second paper.

The Power of Soil and Vegetation combined to destroy Disease Germs, and so prevent the Possibility of the Spread of Enthetic Disease in consequence of Sewage Farming.

By ALFRED CARPENTER, M.D.

At the meeting of the International Medical Congress in London in 1881, I had the privilege of introducing to the notice of the members the subject of sewage utilization by means of irrigation. I submitted nine propositions, and the evidence upon which those propositions were based, viz., the practical experience of twenty-one years' personal observation upon the Croydon sewage farms. A further experience of ten years gained by closely watching the same farms (the areas being increased) has fully confirmed every word put before the great assembly of 1881. No essential part of that evidence has been successfully assailed, and every word might be repeated here if it could be done without loss of time. I will renew the propositions, so far as they bear on the power of soils to destroy the germs which in other positions are capable of spreading infectious disease.

Proposition 1.—That the judicious application of sewage in close proximity to dwelling-houses does not depreciate the health of the inhabitants. A continuation of the table

then given of the vital statistics of the parish of Beddington and of the hamlet of Wallington will afford proof of this contention.

BEDDINGTON.

—	Population.	Rateable Value.	Births.	Deaths under 1 year.	Deaths over 60.	Total Deaths.	Birth rate.	Zymotic Disease.	Death rate.
		£							
1882 ...	2,485	17,689	64	6	3	18	25.7	None.	7.2
1883 ...	2,531	18,532	76	10	9	31	30.	None.	12.2
1884 ...	—	19,120	76	8	8	27	—	3	—
1885 ...	—	19,258	62	5	4	26	—	2	—
1886 ...	—	19,684	78	9	8	31	—	6	—
1887 ...	2,950	20,325	72	8	8	25	24.4	2	8.4
1888 ...	3,000	20,260	72	4	5	23	24.	1	7.6
1889 ...	3,050	20,156	58	3	3	12	19.	None.	3.9
1890 ...	3,250	20,216	61	6	6	16	18.7	2	4.9
1891 ...	—	20,203	—	—	—	—	—	—	—

WALLINGTON.

—	Population.	Rateable Value.	Births.	Deaths under 1 year.	Deaths over 60.	Total Deaths.	Birth rate.	Zymotic Disease.	Death rate.
		£							
1882 ..	3,007	21,912	89	12	10	43	29.5	None.	14.3
1883 ...	3,053	22,578	75	5	8	31	24.5	None.	0.1
1884 ...	—	23,217	92	10	8	33	—	2	4
1885 ...	—	23,888	85	9	19	48	—	2	—
1886 ...	—	25,870	110	8	14	33	—	1	—
1887 ...	4,900	26,172	101	9	7	35	20.5	4	7.1
1888 ...	5,500	26,126	72	10	19	41	13.	4	7.4
1889 ...	5,600	26,176	98	8	13	37	17.5	3	6.6
1890 ...	5,900	26,707	100	10	11	35	16.9	6	5.9
1891 ...	—	26,761	—	—	—	—	—	—	—

It will be observed from this table that the population has increased in a very rapid ratio, which is the more manifest when compared with that of 1861. The census of that year gave a population for the combined districts of 1,557, and a rateable value of £11,700. Notwithstanding the existence of the sewage farm within the distance of less than a mile from the extreme limits of the district, there has been a rapid increase in both population and rateable

value. The high birth rate has naturally raised the death rate, quite independently of outside influences, and the zymotic rate includes diseases such as whooping cough, which cannot be laid to the charge of the farm.

Proposition 2.—That the judicious application of sewage to land will satisfactorily cleanse the effluent water, and fit it for discharge into any ordinary rivulet or water course. Recent analyses of the Beddington effluent, show that after thirty-one years' continuous application of sewage to the same land, there is a persistent power in that land to deal with the applied sewage as satisfactorily as was the case when it was examined by the River Pollution Commissioners in 1867, as reported to Parliament. It may be that the effluent has not been at all times equal to these analyses. Errors of management, absence of manager, great rainfall, cleansing of carriers after haymaking or grass cutting, and the flushing which has to take place after such cleansing, tend for the moment to make the effluent chemically less satisfactory; but in no case has this been more than an accident, which can be, and has been, easily remedied. I need not labour at this proposition. Its truth has been abundantly demonstrated at other places besides Croydon, though not over so long a period of time, and chemical analyses of a highly satisfactory kind have been published in the sanitary journals.

Proposition 3.—That vegetables from fields continuously irrigated by sewage are satisfactory food for man and beast; that animals fed mainly on sewage produce are as healthy as animals fed on ordinary agricultural produce. I prove this by the emphatic statement that no evil effects have been shown to have followed from the consumption of the food which has been grown upon the 600 acres of land irrigated by the Croydon sewage, or on the 1,200 acres irrigated by the Birmingham Corporation. The immense

quantities of food in the way of meat and milk resulting from these large areas must have shown evidence of their unsoundness, if any had really existed. If, in addition to this, I take the evidence afforded by medical superintendents of lunatic asylums, such as that given in September by Dr. C. E. Saunders at Haywards Heath, and Dr. Moody at Cane Hill, it will not be necessary to write more to refute the imaginary notions of those who assume that sewage-grown produce must be unwholesome.

Proposition 4.—That excretions of those suffering from infectious and epidemic disease, when distributed upon land, as in broad irrigation, are immediately rendered innocuous. If rightly dealt with they cannot spread such diseases to those employed on the farm, or injure those who consume the produce, or set up similar disease in those living on the confines of the farm. No evidence has been adduced to contradict this proposition. I append extracts from the reports of the medical officer of health, who, acting for the rural sanitary authority, was not under the jurisdiction of the Croydon authority, and therefore gave an independent opinion.

Mr. Cressy reported (Lady Day, 1883): "I have to report for the year 1882, an immunity from fever of every kind. The area reported upon includes an asylum of 170 girls from eight to sixteen years of age, which has a remarkable freedom from zymotic disease." This paragraph refers to the Beddington Female Orphan Asylum, a building containing nearly 200 occupants, and placed at the south-west corner of the farm, separated by a small brook from fields frequently under irrigation; and a north-east wind carries with it any miasma produced by more than half a mile of irrigated land.

In 1883 there was no outbreak reported except one, which the medical officer considered to have been caused by

polluted water. There were two cases of enteric fever resulting in one death.

In 1885, six cases of diphtheria were reported as arising in South Beddington, in houses at a high level on the chalk (a point the most distant in the parish from the farm) traced to local sanitary defects.

As to 1886, Mr. Cressy reports: "There has been no outbreak of zymotic disease. A case of diphtheria did arise which was imported, but there was no extension." Mr. Cressy, taking a survey in concluding his report says: "The district has been very free from infectious disease."

In 1887, two cases of typhoid, one being fatal, were reported, and referred to dirty hand-flushed w.c.'s. "The record, as far as infectious disease is concerned," says Mr. Cressy, "speaks for itself."

In 1888, he says: "I find the health of my district even better than last year."

These reports corroborate the view put forth in 1881 to the fullest extent. It is true that a new medical officer of health has been recently appointed, who signalised his first report by a suggestion that as he had been unable to trace an outbreak of scarlatina in the Beddington Female Orphan Asylum, it might be produced by emanations from the Croydon sewage farm. This opinion is not supported by evidence worthy of credence:—(1) If it were true, scarlatina must have continuously affected the inmates of the school, and but few, if any, of the children sent there would have escaped the disease. The late Mr. Cressy's reports directly contradict this theory. (2) There are living on the farm several families of children; most of them have not been affected by scarlatina. (3) Considerable numbers of children at Hackbridge on the west, and at Waddon on the east, have never suffered from scarlatina, and the South Norwood district of Croydon, which is close

to the South Norwood farm, has been singularly free from this disease as compared with other districts, and even with other parts of the borough of Croydon, where scarlatina does not exist to anything like the extent found where there are no sewage farms. This clearly shows that the germs which promote the spread of scarlatina are not multiplied in areas devoted to broad irrigation, and it may be fairly assumed that the allied zymotic disorders are not capable of propagation from such areas, otherwise those diseases would be found to be more prevalent among the neighbouring residents than elsewhere. This is certainly not the case at Beddington or Norwood, or in the neighhourhood of any other sewage farm with which I am acquainted. Yet cases of scarlatina do occur in the borough of Croydon, in sufficient numbers for me to say that in no single month in any year have the excreta of scarlatina patients failed to reach the farm at Beddington.

Surely this evidence must be conclusive. I contend that the excreta of infectious patients are not capable of spreading infectious disease, unless they have undergone a zymosis, which cannot take place if the excreta is cooled at once, is aërated as it is on the surface of the soil, and brought into contact with the humus of the earth, and the rootlets of the growing crops. An experience of thirty-one years has not produced any evidence to contradict this proposition. Sewage must be kept near to the surface of the soil so as to have the advantage of sunlight, air, and vegetable life. If sewage percolates deep into the soil out of reach of air and light, the ova of disease germs may be preserved ready for use, upon some other opportunity, and possibly carried away in the effluent water. It is requisite, therefore, that ova be destroyed as well as the germs themselves. This destruction is best effected by vegetable life, and the means whereby this comes about are most numerous on the surface of the soil itself.

In close proximity to the north-western border of the farm is the populous village of Mitcham. Hear what Mr. Marshall, the medical officer of health, reported to the rural sanitary authority in the spring of this year. "Considering the amount of sickness at the beginning of the year as due to the prevalence of the influenza," and at the end of the year to the "severity of the weather, I think the mortality very moderate, as was also the amount throughout the year of zymotic disease. There has been in the district scarlet fever of a mild type, and only one death is recorded."

Birth rate for year ending 31st March, 1891 ... 29·51
Death rate „ „ „ „ ... 11·93

The population of Mitcham is estimated at about 12,500.

Proposition 5.—When examining into this subject some years ago, I carried out a series of observations upon the power of rye grass to deal with the organisms found in sewage. A cubic yard of soil from Beddington was placed in a container and sown with rye grass. The seeds were treated every day with sewage dressings, and the application continued until effluent appeared at the provided outlet. The applied sewage was of the ordinary character; but occasionally urine, swarming with bacteria, was added. Microscopic examination of the effluent failed to discover any of these organisms in the liquid, even after it had been kept for three days. The best time to see the reason of this exemption is about the time at which the plant comes into flower. If the surface of the field is then closely examined, it will be seen to be covered by a felt-like mass of minute radicles extending from the plant at the point at which it is attached to the soil. As the sewage is applied, the rootlets seem to be endowed with life, to become mobile; the bacteria adhere to them as they pass with the sewage through the living filter, and if these rootlets are

examined through a magnifying glass, the germs are seen in an hour or two to disappear from view, as if digested by the plant itself. Hence I have presumed to apply to rye grass the term carnivorous.

It is by this natural process that the ova of disease germs are removed from the sewage, and the effluent satisfactorily cleansed. A similar result occurs when vegetable life is not active. The ulmic salts in the upper part of the soil have an attraction for living organisms similar to that existing in living vegetable root fibres. This humus is only to be found on the surface of the field, and this is the reason why sewage must not be allowed to filter deep into the soil. Intermittent downward filtration is not safe in its results, because the cleansing power of the humus may be overtaken, and disease germs escape with the effluent.

A microscopic examination of the soil from Beddington showed myriads of living organisms within the first three inches of the surface. At a depth of one foot there were found not to be more than a tenth part of those nearer the surface. At two feet deep they were much less numerous; at the depth of a yard they were sometimes absent altogether, though the surface had been irrigated, more or less, during the whole of the year preceding that in which these experiments were carried out. The bacteria found in the soil evidently feed upon the organic matter contained in the sewage, and change it into elements fitted for plant use. It is thus that nature protects us from the natural consequences of animal existence. We have only to see that the laws of the universe are obeyed, and we then escape from the incidence of those diseases which disobedience entails. At the same time we grow increasing quantities of food for those who produce the sewage.

The proposition, therefore, is—Sewage when kept in motion and quickly brought into contact with soil and

vegetable life is changed in a direction contrary to that which is necessary for the propagation of disease germs. It has been asserted that parasitic diseases are spread by sewage farms. I persistently searched for evidence of this before the year 1875, and have continued my observations since. I have not met with cases of tænia solium, or tape worm, in Croydon; there is no evidence of its existence in the case books of the medical officers reporting to the destitution authority (Board of Guardians). If cases had existed, some notice of them must have been found. I placed a mass of evidence on this point in the hands of the late Dr. Cobbold, and invited him to come down and examine for himself a large herd of oxen about to be slaughtered, which had been bred and grown on the Croydon farm. Dr. Cobbold at that time was in bad health and could not come; but, in a letter to me, he withdrew the charges he had made suggesting possible evils attendant on the establishment of sewage farms.

A microscopic examination of the flesh of those animals did not show a particle of evidence in support of the allegations.

To conclude, I have put before you a survey of every point bearing on the hygiene of sewage farming, and I claim to have proved that the utilization of sewage in the manner indicated is a national advantage.

Discussion.

Mr. Raechling followed with an intensely interesting account of the experiments in progress on the irrigation farms in Berlin. The results were of a very satisfactory kind, and, in fact, confirmed all Dr. Carpenter had said in reference to the process first adopted at Beddington Farm, Croydon.

Dr. Gilbert, who is well known as an eminent authority

in these matters, said there could be no question that the land is capable of removing nitrogenous matters, but are objectionable organisms removed? And was it desirable, supposing they were removed, to remove in particular the nitrifying organism which effected oxidation in the effluent? He could not agree with Dr. Carpenter that irrigation would ensure for a large nation like this all that it required in the way of food-supply.

Colonel JONES, whilst agreeing with what Dr. Gilbert had said, always had held that Nature directs in all things the utilization of animal waste for the nourishment of vegetables, and the appropriation of vegetables for the use of animals—in fact, if Nature had her way, there would be no waste at all. He scouted the idea of chemical treatment or precipitation, and ridiculed the idea of the addition of the prescribed amount of lime to so many gallons of sewage as directed by the experts to the London Council. Sewage purification, he contended, was a work for micro-organisms to do, and he had long ago suggested Canvey Island as a ground admirably adapted for this purpose. Referring to the objection that had been raised to the pollution of a river that might ensue from the irrigation method, he stated that he had taken a few days ago a very fine trout from the river Wandle, into which the effluent from the Beddington farm is discharged.

Mr. BREMNER alluded to what he regarded as a new system of dealing with sewage—viz., by aëration. Chemicals were useless, chemicals with centrifugal motion were better, but Nature's own deodoriser—the air—was best. He had treated many gallons of putrescent material, like sewage, with compressed air, and under special precautions which he had taken in machinery of his own devising most excellent results were obtained. In reply to a question from the President, however, he said that no chemical analyses

had been made to show how far this method removed the organic matter from solution.

Dr. C. R. DRYSDALE paid tribute to the excellent work of Dr. Carpenter, whom he characterized as the father of sewage farming, or irrigation. Alluding to the success at Croydon, he said that in consequence of a visit paid to the farm by experts from Berlin and Paris, both places had adopted the system with the same measure of success. It was disgraceful, he added, that London should be behind these cities in this respect, and that what was once a beautiful stream should be by this negligence turned into a river of filth.

Mr. PERRY, who represented the largest parish in the metropolis, had advocated Dr. Richardson's project—that of carrying the sewage by railway to a convenient distance where the land was suitable for irrigation. He proposed to divide London into twelve districts, in order to deal with the sewage adequately. Chemical treatment was a failure, deodorising was a failure, and disinfecting a farce. He could not help feeling, however, that few persons would offer to live in the neighbourhood of a farm where large quantities of sewage were being treated.

Mr. SELLAR, who was the representative of a well-known precipitation company, did not believe in irrigation, and upheld proper chemical or precipitating treatment as the best method not only for removing a nuisance, but for utilizing the product in a dry state for agricultural purposes. He mentioned that the A B C process, as carried out at Kingston-on-Thames, had given satisfaction to the Thames Conservancy, to the Kingston and to the Surbiton authorities.

Dr. CARPENTER said that he thanked the gentlemen who had so kindly spoken of his exertions on behalf of sewage farming. Failures had occurred in some places

and, no doubt, there would be failures still, because those managing the farms had not carried out right principles in their management. They had misunderstood the method of application, and had continued the distribution of sewage on the same plot of land for too long a period without intermission. He would give them a line of operation, which, if followed out, would always save them from failure. Let them be careful to see that their manager always secures at least forty tons of green crops or roots from each acre of land laid out for irrigation, upon which at least 5,000 tons of sewage shall have been distributed during the preceding twelve months. If they are unable altogether to separate the rainfall from the sewage, they must have, in addition, meadows capable of dealing with storm waters. If they cannot sell their produce, they must provide stock so that it may be consumed on or close to the farm. If these principles are generally followed, there will never be another failure in sewage farming. I say nothing about finances—it is the duty of each locality to purify its own sewage, and if the local authority buys land at building prices, it must provide an equivalent for the rental out of the rates. Distance, however, is not to be considered, for so long as sewage is kept moving freely, no putrefactive action will arise, and there are very few places in the kingdom in which land may not be obtained at agricultural prices, if the authority sets about its work in the right way. As to London, if the Canvey Island scheme should not be carried out, I would urge its County Council to secure plots of land from 500 to 1,000 acres in extent, anywhere within thirty miles, wherever they can be secured, erect pumping stations on the principal sewers, and lay a rising main by the nearest road to each of these farms, and they may gradually get rid of their troubles in connexion with the fouling of the river Thames.

Sir HENRY ROSCOE moved and Dr. DRYSDALE seconded : "That, in the opinion of this meeting, the best yet known method of disposing of the sewage of towns is that of purification and utilization on the land."

The motion was carried unanimously, and the meeting then adjourned.